DOCUMENT RESUME

ED 397 846 IR 018 034

AUTHOR Whyte, Michael; And Others
TITLE Cognitive Learning Styles and Their Impact on Curriculum Development and Instruction.
PUB DATE 96
NOTE 19p.; In: Proceedings of Selected Research and Development Presentations at the 1996 National Convention of the Association for Educational Communications and Technology (18th, Indianapolis, IN, 1996); see IR 017 960.
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Armed Forces; Cognitive Psychology; *Cognitive Style; Comparative Analysis; *Computer Uses in Education; *Correlation; Data Analysis; Higher Education; Individualized Instruction; *Information Processing; Instructional Design; Instructional Effectiveness; Job Skills; Learning Theories; *Military Personnel; Student Needs; Teaching Methods; User Needs (Information)
IDENTIFIERS *Air Force; Computer Use; Constructs; Flexibility (Attitude); Gestalt Psychology; Group Embedded Figures Test; Learning Style Inventory (Kolb)

ABSTRACT

This paper highlights extensive previous research on cognitive learning style and describes an investigation of correlated cognitive learning style testing of 107 United States Air Force cadets and officers. The investigation set out to determine whether a multidimensional construct for individuals could be identified, allowing instruction to be adapted to meet the learning needs of students more specifically. In particular, it focused on the relative influence of cognitive learning style on computer utilization and information processing, since these skills are required of most Air Force officers in their work. Results of this study provide a "first look" at previously undocumented information about comparisons of three learning style inventories, the Group Embedded Figures Test (GEFT), the Gestalt Completion Test, and the Kolb Learning Styles Inventory II '85 (LSI 1985). Results compare the Air Force sample's levels of computer expertise with that of the population at large, and explore the number of people tested who display a tendency for field independence and cognitive flexibility. Further investigation of a larger and more representative population from public university settings may well be necessary. Comprehensive data tables and charts show the study results graphically. The paper also includes a profile of "the Air Force officer of today and tomorrow." (Contains 69 references.) (SWC)

Title:

Cognitive Learning Styles And Their Impact On Curriculum Development And Instruction

Authors:

Lt Col Michael Whyte Ph.D.
National Defense Fellow
Howard University

Dolores Karolick
United States Air Force Academy

and

Mona Dee Taylor
Air University

INTRODUCTION

PURPOSE OF STUDY

The study of cognitive styles is not new in the field of educational psychology. The earliest recorded research was conducted at the turn of the century by German psychologists (Coop, 1971). Over 3,000 research studies to date have been conducted in the field of cognitive psychology. According to Chinien and Boutin (1992-93), cognitive styles are defined as the "information processing habits representing the learner's typical mode of perceiving, thinking, problem solving, and remembering." Cognitive style is concerned with how an individual processes information. This includes any process which acquires knowledge (e.g., memory, perception, thought, and/or problem solving). Cognitive styles are not likely to change with time or with training (Ausburn & Ausburn, 1978 and Witkin, Oltman, Raskin, & Karp, 1971). Technology, information systems, and computer based training should, therefore, be tailored to the individual most likely to utilize that system. Conversely, if systems are already in place and cannot be easily adapted or changed, individuals who possess the appropriate cognitive abilities should be selected to use these systems. In a 1994 study, Lyons-Lawrence stated that materials that "stimulate one (individual) may be confusing, distracting, and difficult for another, and too simple for a third." Individuals with various learning styles differ in their performance when using technology. For example, working with computers may be unsuccessful or unproductive if the individual is not visually oriented (Lyons-Lawrence, 1994).

Cognitive style is also not a single entity. Most educational psychologists recognize nine to eleven major dimensions of cognitive style including: scanning; categorizing; reflectivity/impulsivity; and field independence/field dependence (Whyte, 1990 and Whyte, Knirk, Casey, & Willard 1990-91).

Although many cognitive styles have been identified and researched, there have been very few studies which have sought to correlate different measures of cognitive style into a "multidimensional construct" (Kini, 1994). Since there would be a clear advantage to identifying such a construct we attempted to map the "typical" USAF leader of today and tomorrow by seeking to establish a cognitive map of the students and Field Grade officers (i.e., the ranks of Major and Lieutenant Colonel) in the Air Force today.

COGNITIVE STYLE

Cognitive Style Defined

Messick (1976) defines cognitive learning styles in the following quote; "Cognitive learning style helps explain how an individual responds to a wide range of intellectual and perceptual stimuli. Each person's style is determined by the way he takes note of his total surroundings...how he seeks meaning, how he becomes informed. Messick (1984) contains perhaps the most complete discussion of cognitive style available. In his article, Messick defines cognitive style as "characteristic self-consistencies in information processing that develop in congenial ways around underlying personality trends." He also states that cognitive styles are "intimately inter-woven" with motivational, affective and temperamental structures to produce total personality. Perhaps the most prolific writer in the area of cognitive styles was Herman A. Witkin. As part of their extensive research, Witkin, Moore, Goodenough and Cox (1977) determined that cognitive styles: 1) deal with the "form" of cognitive activity, not its content (e.g., thinking, perceiving, problem solving, etc.); 2) are "pervasive dimensions" in that they are a feature of not only personality but also cognition; 3) are stable over time; and 4) are also bipolar. In other words, being on one end of a cognitive style dimension may be useful in some circumstances while not in others. This aspect is in contrast to intelligence, for example, where "more" is always "better."

It is also significant to note that there appears to be a negligible relationship between cognitive style and general intellectual ability. (Ausburn & Ausburn, 1978 and Witkin, Oltman, Raskin, & Karp, 1971). Ausburn (1978) notes that these relationships are extremely negligible and fall short of statistical significance. Although the relationship between IQ and cognitive style appears to be questionable many researchers encourage controlling for intelligence when investigating interactions between cognitive styles and other variables (Ausburn & Ausburn, 1978; Rosenberg, Mintz & Clark, 1977; and Wachtel, 1972).

Related to this research, Witkin, Moore, Oltman, Goodenough, Friedman, Owen and Raskin (1977) determined that there is very little relationship between overall college achievement (i.e., grade point average) and cognitive style.

Studies have shown, however, relationships of cognitive styles and performance in specific subject areas. For example, field independents tend to do better academically in math, science and engineering.

Cognitive style is also not a single entity. Jonassen and Grabowski (1993) list twelve different individual cognitive styles/controls including: 1) Reflectivity/Impulsivity; 2) Focal Attention (Scanning/Focusing); 3) Serialistic/Holistic; 4) Field Independence/Field Dependence; 5) Flexibility (Constricted/Flexible); 6) Category Width (Narrow/Wide); 7) Automization (Strong/Weak); 8) Visual/Haptic; 9) Visualizer/Verbalizer; 10) Leveling/Sharpening; 11) Analytical/Relational; and 12) Complexity/Simplicity.

Implications of Cognitive Style on Computer Utilization

In their 1994 article dealing with "Attributes Affecting Computer-Aided Decision Making," Moldafsky and Kwon state that, cognitive style refers to the characteristic processes individuals exhibit in the acquisition, analysis, evaluation, and interpretation of data used in decision making and has been shown to influence a decision maker's evaluation of an unstructured, strategic planning problem. Recent research has shown a strong link between an individual's cognitive style and their reactions to computer assisted instruction (CAI) or computers in general. According to Moldafsky & Kwon (1994), research indicates that cognitive style can be responsible for an individual's skill in information processing, decision-making attitudes toward computers, and computer anxiety. In 1994, Hsu, Frederick, and Chung found that individuals with particular cognitive styles significantly outperformed others in the recall of the content of computer based instruction. Rowland and Stuessy (1988) is an example of a study which matched alternative modes of CAI to cognitive style. They found that cognitive style, in this case holists and serialists, interacted with various modes of CAI to influence student achievement. Burger (1985) further supports this notion. Her research is another example of a study which investigated the interaction of this particular cognitive style (i.e., field independence/field dependence) and preference for and academic achievement in computer assisted instruction.

Cognitive Style and Information Processing

To provide one clear example of the differences cogni ve style can make between individuals in information processing, at this point we will specifically use Field Dependence/Independence, to describe researched processes, since it is the most widely researched style we included in this study. Witkin, 1977, found that individuals with various cognitive styles, in this case field independents (FIs), are able to precisely identify the critical information contained in a complex visual environment. Field dependents (FDs), on the other hand, generally do not mentally restructure a visual presentation. FDs accept and interact with information the way it is presented (Witkin, 1977 and Dwyer & Moore, 1992). These facts have strong implications for intelligence gathering, information processing, and the critical analysis of visual information. Flannery, 1993, found that FDs process information in a "simultaneous manner." Ideas are seen all at once rather than in some observable order. If information is not connected to something the individual values, it (the information) is discarded. FIs use logical, inductive, information processing. They perceive information objectively. Information for FIs does not have to be concrete or personalized (Flannery, 1993).

PROJECT DESIGN/PARTICIPANTS/MATERIALS

Project Design

In order to attempt to correlate different measures of cognitive style into a "multidimensional construct", we decided to utilize three existing test measurements: Gestalt Completion Test, testing Cognitive Flexibility; Kolb Learning Styles Inventory, evaluates the way individuals learn and deal with ideas and information in day-to-day situations; and Group Embedded Figures Test (GEFT), which determines field independence/dependence. These tests were selected due to their reliability factors and to provide the best description of the "typical" United States Air Force officer cognitive style.

Participants

Selection of participants used in the study came exclusively from the United States Air Force Academy. Current officers at the Major, and Lieutenant Colonel level volunteered to participate in this study and thus represent the officers of today in this study. They were recruited from across educational disciplines, backgrounds and career fields. Information collected about each officer participant included gender, age, rank, number of years of school completed, undergraduate major, graduate major, last degree granted, number of courses completed in computer science, source of

commissioning, primary AFSC/Career Field, amount of Professional Military Education completed, ethnic group and nationality.

To represent the Air Force officer of tomorrow, we surveyed the current cadet population at the Air Force Academy. We randomly selected senior and junior undergraduate level students. These students included cadets in leadership and non-leadership positions, randomly placed by the registrar in class sections of core Military Art and Science courses. We collected information from each cadet participant on gender, date of birth, class level, number of courses completed in computer science, ethnic group, nationality, and academic major.

The three cognitive styles tests were administered to all participants in classroom environments. They were typically all administered at one sitting. On occasion the GEFT tests were administered in one class session and the other two tests in a different class session due to class time availability. This is not seen by the researchers as a confounding factor since the tests do not build upon each other in any way. All tests were collected, scored, and data compiled through the use of SPSS.

TESTING MATERIALS

GROUP EMBEDDED FIGURES TEST (GEFT)

The Group Embedded Figures Test (GEFT), measures the cognitive style dimension of field independence and field dependence. The GEFT consists of 18 complex figures. Individuals must find a simple embedded geometric figure which is hidden in a complex one (Donlon, 1977; Thompson & Meloncon, 1987; Willard, 1985 and Witkin, Oltman, Raskin & Karp, 1971). As in previous studies, students who fall "at or above the third quartile" will be designated as field independent. Field dependents are those "whose scores on the GEFT fall at or below the point that represents the first quartile." The reliability of this test is .82 for both males and females (Canino, 1988 and Whyte, 1990).

Overview of Field Independence/Field Dependence

According to Rasinski (1983), field independence/field dependence is "by far" the most researched of all cognitive styles. Most research in this area began in the early 1950's and 1960's (Witkin, Lewis, Hertzman, Machover, Bretnall Meissner & Wapner, 1954 and Karp, 1963). Herman A. Witkin, Donald R. Goodenough and Philip K. Oltman have produced most of the substantive research in this area in the last 30 years (Bertini, Pizzamiglio, & Wapner, 1986 and Witkin & Goodenough, 1981). Goodenough (1976) defines field independent individuals known as analytic or articulate, and field dependent individuals known as global.

According to Willard (1985), this dimension is concerned with an individual's ability to "perceive a part of a stimulus as discrete from its surroundings through active and analytic as opposed to passive and global processes." It is also significant to note that the field independence/field dependence dimension is "bipolar." According to Witkin and Goodenough (1977), "each of the contrasting cognitive styles has components that are adaptive to particular situations, making the dimension value neutral."

Personality Traits of Field Independents/Dependents

In an early work, Witkin, Lewis, Hertzman, Machover, Bretnall Meissner, and Wapner (1954) described a field independent individual as almost the complete opposite of a field dependent. A field independent is analytical, independent, and can function with very little environmental support. He/she also tends to have low anxiety and a high self-image. A field dependent, on the other hand, is passive, shows a lack of initiative and has a readiness to submit to authority. Although field dependents tend to be warm and likable they generally have low self-images.

In a follow-up book, Witkin and Goodenough (1981) found that based on a field independent's personality characteristics they also tend to keep to themselves or desire to work alone. They are sometimes viewed, as a result, as inconsiderate, distant and demanding. Field dependents generally make greater use of information from other students (Willard, 1985.)

Specific Characteristics of Field Independence/Dependence

Field Independence

Canino and Cicchelli (1988) define field independent individuals as those who are capable of perceiving items as discrete from background or field. They also learn better when they are allowed to develop their own strategies in problem-solving nonsocial domains. As part of their extensive research, Witkin and Goodenough (1977) stated that field independents: prefer solitary activities; are individualistic; are cold and distant in relations with others; are aloof; never feel like embracing the whole worl; are not interested in humanitarian activities; value cognitive pursuits; are concerned with philosopical problems; are task oriented; have work oriented values such as efficiency, control, competence, and excelling.

Extensive amounts of research which delineate various attributes of field independent individuals have been compiled (Goodenough, 1976; Guerrieri, 1978; Malancon & Thompson, 1990; Mikos, 1980). The following is a compilation of pertinent research:

1. Field independent (FI) elementary students gain conservation ability more quickly than FD counterparts (Wicker, 1980).
2. FI's seem to be able to learn concepts more efficiently (Stasz, Shavelson, Cox, & Moore, 1976).
3. FI's have better reading comprehension skills (Pitts & Thompson, 1984; Rasinski, 1983; and Spiro & Tirre, 1979).
4. It was reported that high scores on Witkin's tests (i.e., FI) indicate high spacial and artistic abilities (Mayo & Bell, 1972).
5. FI's tend to favor analytical professions (e.g., experimental psychology, mathematics, surgical nursing) (Rosenberg, Mintz & Clark, 1977).
6. A significant number of engineers are field independent (Barrett & Thornton, 1967).
7. FI's are likely to make the following vocational choices: science and industrial arts teachers; and production managers (Witkin, Moore, Oltman, Goodenough, Friedman, Owen & Raskin, 1977).
8. Field independence is linked to academic achievement (e.g., passing the GED exam) (Donnarumma, Cox & Beder, 1980).

Field Dependence

Field dependent individuals are almost complete opposites of their counterparts. Canino and Cicchelli (1988) define field dependent learners as those who are not as able to separate "elements from their surroundings." They experience their environment more globally and usually accept the organization provided by the "perceptual field." FDs also prefer to interact with a teacher and tend to learn better with structure. Witkin and Goodenough (1977) stated that field dependents: like being with others, are sociable, are gregarious, are affiliation oriented, are socially outgoing, prefer interpersonal and group to intrapersonal circumstances, seek relations with others and show need for friendships, show participativeness, are interested in people and want to help others, and now many people and are known to many people.

As stated above, extensive research has been compiled which delineates various attributes of the field dependent dimension (Goodenough, 1976; Guerrieri, 1978; Malancon & Thompson, 1990; and Mikos, 1980). The following is a compilation of pertinent research:

1. Field dependents show a much greater preference for working physically closer to others than FIs (Witkin & Goodenough, 1977).
2. Field dependent people also not only prefer more to be with people but also tend to be more popular with peers (Malancon & Thompson (1990.)
3. FDs tend to favor the vocational choices of social studies and elementary school teachers (Witkin, Moore, Oltman, Goodenough, Friedman, Owen & Raskin, 1977).
4. Field dependents are also attracted to "interpersonal" occupations (e.g., social work, psychiatric nursing and clinical psychology) (Rosenberg, Mintz & Clark, 1977).

GESTALT COMPLETION TEST

The Gestalt Completion Test measures cognitive flexibility and is one of 72 factor-referenced cognitive tests provided by the Education Testing Service and a part of the Kit of Factor-Referenced Cognitive Tests (1976). This test specifically measures the speed of closure which is defined as *the ability to write an apparently disparate perceptual field into a single concept* (Ekstrom, French, Harman and Dermen, 1976). These same authors identified that, "According to Carroll (1974), speed of closure 'requires a search of a long-term memory visual-representatinal memory store for a match for a partially degraded stimulus cue.' Strategies employed may include utilizing hypotheses from association in long-term memory or restructuring the stimulus perception." This test requires the participant to discern individual pieces of a whole and identify the whole figure or picture. There are no clues provided as to what the complex figure may be. No context is provided for reference to environment or cognitive situation. The test is comprised of two samples to familiarize participants with expectations. The remainder of the test is divided into two sections, each with ten boxes containing incomplete black and white pictures. Participants are asked to identify the objects within the boxes using only their imaginations. There are two minutes allowed to complete each section. Scores run on a continuum from 1 through 20 with 1 representing the highly constricted learner and 20 representing the highly flexible learner.

As identified by two independent testing sources provided in the Kit of Factor-Referenced Cognitive Tests (1976), the reliability of the Gestalt Completion test among college aged participants varies from .85 to .82. This high level of reliability led to our selection of this cognitive test for inclusion is this study.

Overview of Cognitive Flexibility

Cognitive flexibility has been studied very little in comparison to Field Independence/dependence or Kolb's Learning Style Inventory. We determined, however, that because of its supposed relationship to FI/FD that it must be included to determine a clearer picture of the cognitive style of the typical Air Force Officer. Characteristics of this style imply different abilities and approaches to problem solving than does FI/FD. Cognitive Flexibility as identified by Jonassen and Grabowski (1993), "..is a measure of the ability to ignore distractions in order to focus on relevant stimuli (Klein, 1954).."

The identification of cognitive flexibility stems from clinical research accomplished primarily by Gardner and Klein and secondarily by some of their colleagues at the Menninger Clinic. They were primarily researching the concept of how cognitive structures modulate and control human drives. The distinct difference in their research was directed toward the element that personality plays in determining cognitive roles. This element was defined by Klein as cognitive style, which also contains the components of emotion, motivation and affective elements (Ludwig & Lazarius, 1983).

Specific Characteristics of Cognitive Flexibilty

Flexibility

Flexible processors, according to Jonassen and Grabowski (1993), are: focused, analytical, open to change, use feelings and other emotions, use internal cues as information sources, use all available external cues.

Constricted

Constricted processors according to the same sources display characteristics opposite to those of Flexible individuals. Those characteristics are described as: distracted, global, resistant to change, avoid feelings or emotion, use reaction as information sources, over generalize cognitive set cues.

Recent research involving cognitive flexibility is looking at Hypermedia and the application of knowledge in new situations, comprehension, problem solving, and decision making. Findings in these studies, however, are not yet generalizable to this study. Reference research will continue to be made to identify any computer skill attributions and related findings concerning this cognitive style which may impact future implications.

KOLB LEARNING STYLES INVENTORY II '85 (LSI 1985)

Kolb's Learning Style Inventory II '85 is a tool recognized in the education community for the measurement of an individual's intrinsic learning style or individuals predisposition in any given learning situation. It was developed according to the theory of learning expressed in the Experiential Learning Model (ELM) (Kolb, 1974; Kolb, 1976; Kolb,

Rubin and McIntyre, 1974). It was designed to be utilized specifically with an adult population in education or employment settings. In 1985 the Learning Style Inventory underwent a revision intended by David A. Kolb as "improvements designed to enhance the scientific measurement specifications and the inventory's practical uses in education and counseling" (Technical Specifications, 1985). The LSI 1985 is a set of 12 completion statements with 4 rank ordered endings requiring approximately 10 minutes to complete and another 5 to 10 minutes to self-score.

Reliability and Validity

Technical Specifications (1985) reports very good internal consistency coefficients as measured by Cronbach's α coeffiecients (ranging from .82 for Concrete Experience (CE) and .83 for Abstract Conceptualization (AC) to .78 for Active Experimentation (AE) and .73 for both Reflective Observation (RO). Tukey's test measured an almost perfect additivity of 1.0 (Technical Specification, 1985.) Similar data on internal consistencies or reliabilities were reiterated in subsequent studies by Sims, Veres III, Watson, and Buckner (1986) Sims, Veres III, and Shake (1989).

Validity is reflected in the intercorrelations among the mode of lerning style and difference scores on the (AC-CE) and (AE-RO) bipolar dimensions. As expected, these intercorrelations are in the negative direction although they vary greatly in magnitude. the ranges were reported from -.05 to -.85 with an absolute value mean of .36.

These findings are substantiated by Cornwell and Manfredo (1994). Their findings tended to support Kolb's generalizations about the relationship of any two learning orientations to a respective learning style.

1. (AE) "doing" and (CE) "feeling" to Accomodators
2. (RO) "watching" and (CE) "feeling" to Divergers
3. (RO) "watching" and (AC) "thinking to Assimilators
4. (AE) "doing" and (AC) "thinking" to Convergers

Cornwell et al. described a "functional relationship existing between the two learning style typologies such that each classification of learning orientation corresponds to only two classifications of the learining typology. As an example, primary learning style (PLS) "feeling" corresponds to learning style type (LST) diverger or accommodator. Similarly, LST accommodator corresponds to PLS "feeling" and "doing" (1994).

David A. Kolb defines learning styles as an individual's self-diagnosed, preferences in the perception and subsequent processing of information (Kolb, 1984; Jonassen & Grabowski, 1993). Crossing the perceptual bi-polar continuum of concrete experience (CE) versus abstract conceptualization (AC) with the information transformational bi-polar continuum of reflective observation (RO) and active experiementation (AE) differentiates four types of learning styles.

1. ***Divergers*** experience their environment concretely through their feelings related to the tangible here and now (CE) and transform it through internal reflection or thought (RO)
2. ***Assimilators*** experience their world symbolically through abstract conceptualization (AC) and transform it through thought (RO) as the Divergers.
3. ***Convergers*** perceive their environment through analytic thought or abstract conceptualization (AC) and transform that information through action (AE)
4. ***Accomodators*** grasp their environment concretely through their feelings (CE) and also utilize action or actively manipulate their environment (AE) to transform these experiences or information (Jonassen & Grabowski, 1993; Krahe, 1993)

Heredity, previous formal or informal socialization and education experiences, as well as the immediate environment play a large part in the tendency of an individual to favor some learning abilities over others.

Specific Characteristics of Kolb's Learning Styles

Jonassen and Grabowski (1993) described some general strengths and weaknesses associated with each of the four learning styles reflecting the bi-polar nature of the dimension reflecting the individual's perception of information in addition to how that individual transforms or processes that information.

Divergers

Divergers have the ability to assimilate or synthesize a wide-range of disparately different observations into a comprehensive explanation. This enables them to generate many ideas. they are intuitive, imaginative, have many broad cultural interest, and are able to perceive many divergent viewpoints. their people-oriented skills enable them to relate well to others. On the downside, Divergers are "less concerned with theories or generalizations" (p.250). they approach situations in a less thoughtful, systematic or scientific way. This inhibits their ability to make decisions.

Assimilators

Assimilators take a focused, systematic and scientific approach to their environment. This use of logic, inductive reasoning skills, and the ability to view multiple perspectives is needed to theoretically model building. This is reflected in their ability to organize information well which is needed in the design of stable experiments. Assimilators prefer analytic, abstract, and quantitative task and, conversely, feel uncomfortable performing qualitative or concrete tasks. They focus less on interpersonal, people oriented skills which reduces their ability to impact or influence others. Because they are less action oriented, they are less able to apply theories and model to the real world.

Convergers

Convergers bring a logical, pragmatic, as well as focused and unemotional perspective to any situation. They have the ability to problem solve, make thoughtful decisions, and get the job done, many times, creating new ways of thinking and doing when the situation needs it. Their focus on the analytical reduces the intuitive understanding necessary in relation to people skills and increases their discomfort concerning social or interpersonal issues. They are sometimes considered non-artistic, unimaginative and closed minded which can tend toward a narrow range of interests. They are uncomfortable with the qualitative or the concrete. They are more concerned with the "relative" truths than absolute truths.

Accomodators

Accomodators prefer to carry out plans which produce action and results based on facts and reality. They are risk takers and enjoy seeking out new experiences. This enables them to adapt to new situations and environments well. Their op-minded, intuitive, people oriented approach enables them to influence and lead others or impact a situation because of their personal involvement. Because they rely more heavily on other people for information, they are less scientific, systematic, and analytical in their approach to a given situation. they tend to favor a trial-and-error approach to their environment disregarding theory. They are sometimes perceived as impatient and controlling. Like the converger, they are less concerned with absolute truth the "relative" truth.

RESULTS/DATA ANALYSIS

RESULTS

The total sample size equaled 107; 77 cadets, 30 officers. Following are percentage breakdowns of the total population for gender, nationality, ethnic group, undergraduate major and number of courses in computer science.

Gender:	85% male 15% female
Nationality:	94.4% American 1.9% Other 3.7% Not reported
Ethnic Group:	5.6% African American 5.6% Asian 1.9% American Indian 1.9% Hispanic 81.3% Caucasian 3.7% Not reported

Undergraduate Major:	2.8% Behavioral Science
	7.5% Biology
	12.1% Business/Management
	9.3% Computer Science
	.9% Economics
	35.5% Engineering
	10.3% Geography
	4.7% History
	.9% Languages
	2.8% Math
	2.8% Physics
	9.3% Political Science
	10.3% Other
Computer Science Crs:	1.9% No courses
	64.5% 1-2 courses
	17.8% 3-4 courses
	5.6% 5-6 courses
	5.6% 7-8 courses
	1.9% 9-10 courses
	2.8% 11+ courses

These statistics identify that this sample population mirrors the Air Force of today by gender. It is representative of a primarily American population with diverse ethnicity. Fields of undergraduate study range over more than twelve different subject areas, identifying multiple interests and expertise throughout the group. Finally, these statistics identify that this population is familiar with computers and operations of computers in their lives with 98.1% having taken a minimum of 1+ courses in computer science.

CADET POPULATION

The cadet population closely mimics the population sample as a whole. The percentages are only slightly different but emphasize the same representative population over all. Following are the specifics:

Gender:	90.9% male
	9.1% female
Nationality:	97.4% American
	2.6% Other
Ethnic Group:	5.2% African American
	6.5% Asian
	2.6% American Indian
	2.6% Hispanic
	83.1% Caucasian
Undergraduate Major:	2.6% Behavioral Science
	5.2% Biology
	15.6% Business/Management
	9.1% Computer Science
	1.3% Economics
	40.3% Engineering
	5.2% History
	2.6% Math
	6.5% Political Science
	11.7% Other

Computer Science Crs:	74.0% 1-2 courses
	13.0% 3-4 courses
	5.2% 5-6 courses
	6.5% 7-8 courses
	1.3% 9-10 courses

The only identifiable differences between the cadet population and whole sample were in undergraduate major, where Physics, Language and Geography were not identified as a major area of study. Additionally, no students had taken above 11 computer science courses. These differences are not considered by the researchers to be significant since the percentages in the main populations for these features were minute.

Consistency with the total population is significant. Gender representation for cadets was 10% female, which is in direct correlation with the Air Force as a whole. 97.2% are American, with primarily a Caucasian ethnicity, but with representation from multiple groups. Undergraduate major had the largest percentage in Engineering, but a representation at some fairly high levels appeared in 9+ major areas indicating diverse interests and expertise. All cadets have had at least one to two courses in computer science.

Officer Population

Following are the statistics for the officer population in comparison to the total sample.

Gender:	70% male
	30% female
Nationality:	86.7% American
	13.3% Not reported
Ethnic Group:	6.7% African American
	3.3% Asian
	76.7% Caucasian
	13.3% Not reported
Undergraduate Major:	3.3% Behavioral Science
	13.3% Biology
	3.3% Business/Management
	10.0% Computer Science
	23.3% Engineering
	3.3% Geography
	3.3% History
	3.3% Languages
	3.3% Math
	10.0% Physics
	16.7% Political Science
	6.7% Other
Computer Science Crs:	6.7% No courses
	40.0% 1-2 courses
	30.0% 3-4 courses
	6.7% 5-6 courses
	3.3% 7-8 courses
	3.3% 9-10 courses
	10.0% 11+ courses

These, again, correlate very highly with the percentages of the total sample. The officers had more computer science courses than the sample or the cadets. Officers had a higher population of females who participated. The ethnic diversity was not as broad, but still represented more than one ethnic group.

In addition to the identified categories for the cadets and the whole sample, the following data was collected specifically for officers. This was to identify who the members of this group were in relation to the total Air Force population.

AFSC	6.7% Acquisition/Contracting
	3.3% Air Defense
	3.3% Civil Engineering
	10.0% Communication
	6.7% Engineering
	3.3% Intelligence
	3.3% Missiles
	10.0% Navigator/Weapons Systems
	20.0% Pilot
	6.7% Space Operations
	6.7% Other
	20.0% Not identified
COMMISSIONING SOURCE	20.0% AFROTC
	16.7% OTS
	43.3% USAFA
GRADUATE MAJORS	3.3% Behavioral Science
	10.0% Biology
	3.3% Business/Management
	13.3% Computer Science
	6.7% Education
	20.0% Engineering
	3.3% Geography
	3.3% Languages
	10.0% Physics
	13.3% Political Science
	13.3% Other
PROFESSIONAL MILITARY EDUCATION	
	33.3% SOS
	36.7% Intermediate Service School
	10.0% Senior Service School
RANK	6.7% O-3
	56.7% O-4
	36.7% O-5

This data indicates that the participating population does represent the Air Force of today. Eleven+ AFSCs are represented, with officers from all commissioning sources. Graduate majors are as varied as the undergraduate majors. A slightly larger Majors participation than Lt. Colonel which coincides with actual numbers of officers in the Air Force at those levels today.

Because of the congruence between cadets and officers in comparing all collected data, including the learning styles results, we will only identify the findings from this point forward for the group as a whole.

F llowing are the results for each individual cognitive style tested for with the participants. The results stand alone and reflect scoring of the tests based upon requirements of each testing mechanism.

FI/FD

FIELD DEPENDENCE/INDEPENDENCE

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
FI	1	92	86.0	86.0	86.0
>FI	2	7	6.5	6.5	92.5
>FD	3	2	1.9	1.9	94.4
FD	4	6	5.6	5.6	100.0
Total			107.0	100.0	100.0

Figure 2

As the chart (figure 1) above illustrates this population is 86.9 extremely field independent. The combination of FI and >FI make up 92.5% of the population with only 7.5% of the total population being a combination of FD and >FD, identifying a clear tendency for Field Independence.

COGNITIVE FLEXIBILITY

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Extreme Flexible	1	53	49.5	49.5	49.5
Flexible	2	51	47.7	47.7	97.2
Constricted	3	3	2.8	2.8	100.0
Total			107.0	100.0	100.0

Figure 3

Since the tendency for cognitive flexibility is expressed along a continuum from 0 to 20, this team of researchers divided the continuum into four quartiles:

0-5 = extremely constricted
6-10 = constricted
11-15 = flexible
16-20 = extremely flexible

These quartile identifiers allowed us to determine to what extent this population is cognitively flexible or constricted. The chart above clearly demonstrates that our participants are 97.2% cognitive flexible, with an approximate 50-50 split between extremely flexible and flexible. Only three participants out of 107 tested constricted with 0 testing extremely constricted.

KOLB LEARNING STYLE INVENTORY

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Diverger	1	15	14.0	14.0	14.0
Assimilator	2	26	24.3	24.3	38.3
Converger	3	50	46.7	46.7	85.0
Accomodator	4	16	15.0	15.0	100.0
Total			107	100.0	100.0

Figure 4

As reflected in this chart 46.7% of the participants tested out as Convergers with the next largest population being Assimilators at 24.3%.

Comparison of Test Materials

As a further demonstration of the statistics, following are three charts; one comparing Cognitive Flexibility and FI/FD, two comparing Kolb Learning Style and FI/FD, and the third comparing Kolb Learning Style and Cognitive Flexibility. A Chi-square has been run with these cross tabs to determine any levels of significant.

COGNITIVE FLEXIBILITY VS FIELD DEPENDENCE/INDEPENDENCE

FLEXIBILITY

	Count	Extreme Flexible 1	Flexible 2	Constricted 3	Row Total	%
FI/FD						
FI	1	47	43	3	93	86.9
>FI	2	2	4		6	5.6
>FD	3	2			2	1.9
FD	4	2	4		6	5.6
	Column Total	53 49.5	51 47.7	3 2.8	107	100.0

Chi-Square	Value	DF	Significance
Pearson	4.03688	6	.67168
Likelihood Ratio	5.12545	6	.52783

Figure 5

KOLB LEARNING STYLE VS FIELD DEPENDENCE/INDEPENDENCE

		KOLB LRN STYLE					
		Diverger	Assimilator	Converger	Accomodator	Row	
	Count	1	2	3	4	Total	%
FI/FD							
FI	1	12	25	43	13	93	86.9
>FI	2			5	1	6	5.6
>FD	3	1			1	2	1.9
FD	4	2	1	2	1	6	5.6
	Column Total	15 14.0	26 24.3	50 46.7	16 15.0	107	100.0

Chi-Square	Value	DF	Significance
Pearson	11.32612	9	.25402
Likelihood Ratio	12.93238	9	.16569

Figure 6

KOLB LEARNING STYLE VS COGNITIVE FLEXIBILITY

	KOLB LRN STYLE						
		Diverger	Assimilator	Converger	Accomodator		
	Count	1	2	3	4	Row Total	%
FLEXIBILITY							
Extreme Flexible	1	9	10	23	11	53	49.5
Flexible	2	6	15	25	5	51	47.7
Constricted	3		1	2		3	2.8
	Column Total	15 14.0	26 24.3	50 46.7	16 15.0	107	100.0

Chi-Square	Value	DF	Significance
Pearson	5.21428	6	.51664
Likelihood Ratio	6.05043	6	.41757

Figure 7

The Air Force Officer of Today and Tomorrow

Based upon the data collected we have determined:

1. The Air Force Officer of today and tomorrow vary little in their statistical makeup.
2. They are field independent, cognitively flexible and convergers. These three styles have common characteristics, independently defined, as supported by the literature. Common characteristics of these three styles include

- Analytical, logical, pragmatic
- Concern for ideas and principles
- Prefer solitary activities, individualistic
- Focused, unemotional perspective to situations
- Self motivated, favor lectures in learning
- Have excellent reading comprehension skills
- Superior problem solvers, adapting the approach to the problem
- Do not require externally provided structure
- Open to change
- Creates new ways of thinking and doing when the situation requires
- Work oriented values such as efficiency, control competence, and excelling
- Considered non-artistic
- Select scientific, experimental psychology, mathematics, and engineering careers
- Efficient at restructuring and organizing visual/spatial information
- Adept at processing unusually complex visual materials

DISCUSSION/IMPLICATIONS

Based upon this initial research, it appears that it may be possible to identify a multidimensional construct for individuals. These researchers believe that if two multidimensional constructs which were bipolar could be identified, instruction could then be adapted to meet the needs of students more specifically. With the extremes identified, the needs of the individuals leaning in either direction would also be met. While we believe this baseline study provides a "first look" at previously undocumented information about comparison of three learning styles inventories, the door to what this means has only been slightly opened.

Future studies should include a larger population of individuals from public university settings. While this group was highly representative in many areas, it did not represent a normal population spread for gender or nationality. It would be important to test students at international universites to see if a this construct could be generalized to a larger population.

Only three tests were used in this baseline study. We must expand the number of cognitive tests used to provide a more extensive picture of this multidimensional construct. Styles such as visual/verbalizer, locus of control, impulsivity/reflectivity, and cognitive width would provide a more in-depth picture of our population.

We must look at development of a test environment which mimics the real world to see how individuals approach problem solving and decision making. We should track such items as cognitive strategy and time on task, which could identify ability to perform in stressful situations.

Clearly, much research is still needed. This study only takes a beginning look at the implications of cognition and a multidimensional construct. Future study can only enhance this look and provide necessary, vital approaches to instructional design and delivery.

REFERENCES

Ausburn, L. J. & Ausburn, F. B. (1978, Winter). Cognitive Styles: Some Information and Implications for Instructional Design. Educational Communication and Technology, 26(4), 337-354.

Barrett, G. V. & Thornton, C. L. (1967). Cognitive Style Differences Between Engineers and College Students. Perceptual and Motor Skills, 25(3), 789-793.

Berry, L. H. (1984). The Role of Cognitive Style in Processing Color Information: A Signal Detection Analysis. Proceedings of Selected Research and Development Presentations at the Convention of the Association for Educational Communications and Technology. (ERIC Document Reproduction Service No. 243 414).

Bertini, M., Pizzamiglio, L., & Wapner, S. (Eds.). (1986). Field Dependence in Psychological Theory, Research, and Application. Hilldale, New Jersey: Lawrence Erlbaum Associates, Publishers.

Burger, K. (1985). Computer Assisted Instruction: Learning Style and Academic Achievement. Journal of Computer Based Instruction, 12(1), 21-22.

Canino, C. & Cicchelli, T. (1988). Cognitive Styles, Computerized Treatments on Mathematics Achievement and Reaction to Treatments. Journal of Educational Computing Research, 4(3), 253-264.

Carroll, R.P. Psychometric tests as cognitive tasks: A new "structure of intellect." Princeton, N.J.: Educational Testing Service, Research Bulletin 74-16, 1974.

Chinien, C. A. & Boutin, F. (1992-93). Cognitive Style FD/I: An Important Learner Characteristic for Educational Technologists. Journal of Educational Technology Systems, 21(4), 303-311.

Coop, R. H. & Brown, L. D. (1970). Effects of Cognitive Style and Teaching Method on Categories of Achievement. Journal of Educational Psychology, 61(5), 400-405.

Coop, R. H. & Sigel, I. E. (1971). Cognitive Style: Implications for Learning and Instruction. Psychology in the Schools, 8, 152-161.

Cornwell, J. M. & Manfredo, P. A. (1994). Kolb's Learning Style theory Revisited. Educational and Psychological Measurement, 54 (2), 317-327.

Dixon, N. (1982, July). Incorporating Learning Style into Training Design. Training and Development Journal, 36(7), 62-64.

Donlon, T. F. (1977). A Practical Assessment of Field Dependence/Independence. Paper presented at the annual meeting of the New England Educational Research Association, Manchester-Bedford, NH. (ERIC Document Reproduction Service No. ED 139 827)

Donnarumma, T., Cox, D., & Beder, H. (1980). Success in a High School Completion Program and its Relation to Field Dependence-Independence. Adult Education, 30, 222-232.

Dwyer, F. M. & Moore, D. M. (1992). Effect of Color Coding on Cognitive Style. Proceedings of Selected Research and Development Presentations at the Convention of the Association for Educational Communications and Technology. (ERIC Document Reproduction Service No. 347 986).

Ekstrom, R.B., French, J.W., Harman H.H., Dermen, D. (1995). Manual for Kit of Factor-Referenced Cognitive Tests. Educational Testing Service, Princeton, New Jersey.

FitzSimonds, J. R. (Decemer, 1994). The Revolution in Military Affairs: *Changes for Defense Intelligence*, 1-9.

Flannery, D. D. (1993). Global and Analytical Ways of Processing Information. New Directions for Adult and Continuing Education, 59, 15-24.

Goodenough, D. R. (1976). The Role of Individual Differences in Field Dependence as a Factor in Learning and Memory. Psychological Bulletin, 83(4), 676-694.

Guerrieri, J. A. (1978). The Interactive Effects of Cognitive Style and Learner Preparation on Cognitive Learning. Unpublished doctoral dissertation. University of Southern California.

Hahn, J. S. (1984). An Exploratory Study of the Relationship Between Learner Cognitive Styles and Three Different Teaching Methods Used to Teach Computer Literacy with the Pittsburgh Information Retrieval System (PIRETS). International Journal of Instructional Media, 11(2), 229-291.

Hickcox, L. K. (1992, November). Kolb's Exeriential Learning Theory: An Historical Review and its effects in Higher and Adult Education - 1971-1991. Columbia, Maryland: Council for Adult and Experiential Learning.

Hsu, T. E., Frederick, F. J., & Chung, M. (1994). Effects of Learner Cognitive Styles and Metacognitive Tools on Information Acquisition Paths and Learning in Hyperspace Environments. Proceedings of Selected Research and Development Presentations at the Convention of the Association for Educational Communications and Technology.

Jonassen, D. H. & Gabowski, B. L. (1993). Handbook of Individual Differences, Learning, and Instruction. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Kagan, J. & Kogan, N. (1970). Individual Variation in Cognitive Processes. In P. H. Mussen (Ed.), Carmichael's Manual of Child Psychology (3rd. ed.) (Vol. 1). (pp. 1273-1366). New York: John Wiley & Sons, Inc.

Karp, S. A. (1963). Field Dependence and Overcoming Embeddedness. Journal of Consulting Psychology, 27(4), 294-302.

Kini, A. S. (1994). Effects of Cognitive Style and Verbal and Visual Modes on Concept Learning in CBI. proceedings of Annual Meeting of the American Educational Research Association. (ERIC Document Reproduction Service No. ED 371 032).

Klein, G.S. (1954). Need and Regulation in Nebraska Symposium on Motivation. Lincoln, NB: University Press.

Kolb, D. A. (1984). Experiential Learning: Experience as the Source of Learning and Development. Englewood Cliffs, Prentice-Hall, Inc.

Krahe, V. A. (1993). The Shape of the Container. Adult Learning, 17-18.

Leader, L. F. & Klein, J. D. (1994). The Effects of Search Tool and Cognitive Style on Performance in Hypermedia Database Searches. Proceedings of Selected Research and Development Presentations at the Convention of the Association for Educational Communications and Technology.

Ludwig, R. P. and Lazarus, P. J. (1983). Relationship between shyness in children and constricted control as measured by the Stroop Color-Word Test. Journal of Consulting and Clinical Psychology, 51 (3), 386-389.

Lyons-Lawrence, C. L. (1994). Effect of Learning Style on Performance in Using Computer-Based Instruction in Office Systems. The Delta Pi Epsilon Journal, 36(3), 166-175.

Mayo, P. R. & Bell, J. M. (1972). A Note on the Taxonomy of Witkin's Field-Independence Measures. British Journal of Psychology, 63(2), 255-256.

McBer & Co. (1985). Learning-Style Inventory, 1985: Technical Specifications. Boston: McBer & Co.

Melancon, J. G. & Thompson, B. (1989). Measurement Characteristics of the Finding Embedded Figures Test. Psychology in the Schools, 26, 69-78.

Melancon, J. G. & Thompson, B. (1990). Maximizing Test Reliability by Stepwise Variable Deletion: A Case Study with the Finding Embedded Figures Test. Perceptual and Motor Skills, 70, 99-110.

Messick, S. (1984). The Nature of Cognitive Styles: Problems and Promise in Educational Practice. Educational Psychologist, 19(2), 59-74.

Mikos, R. (1980). The Interrelation of Instructional Strategies and Learner Aptitude Profiles on the Performance and Retention of a Complex Psychomotor Task. Unpublished doctoral dissertation. University of Southern California.

Moldafsky, N. I. & Kwon, I. (1994). Attributes Affecting Computer-Aided Decision Making--A Literature Review. Computers in Human Behavior, 10(3), 299-323.

Oltman, P. K., Goodenough, D. R., Witkin, H. A., Freedman, N., & Friedman, F. (1975). Psychological Differentation as a Factor of Conflict Resolution. Journal of Personality and Social Psychology, 32(4), 730-736.

Paradise, L. V. & Block, C. (1984). The Relationship of Teacher-Student Cognitive Style to Academic Achievement. Journal of Research and Development in Education, 17, 57-61.

Post, P. E. (1987). The Effect of Field Independence/Field Dependence on Computer-Assisted Instruction Achievement. Journal of Industrial Teacher Education, 25(1), 60-67.

Publication Manual of the American Psychological Association. (1988). Washington, D.C.: American Psychological Association.

Rasinski, T, (1983). Cognitive Style and Reading: Implications from Field Dependence Research for Reading Instruction. Paper presented at the annual meeting of the Great Lakes Conference of the International Reading Association, Springfield, IL. (ERIC Document Reproduction Service No. ED 241 899)

Renninger, K. A. & Snyder, S. S. (1983). Effects of Cognitive Style on Perceived Satisfaction and Performance Among Students and Teachers. Journal of Educational Technology, 75(5), 668-676.

Reynolds, J. & Gerstein, M. (1992). Learning Style Characteristics: An Introductory Workshop. The Clearing House, 122-126.

Ronning, R. R., McCurdy, D., & Ballinger, R. (1984). Individual Differences: A Third Component in Problem Solving Instruction. Journal of Research in Science Teaching, 21, 71-82.

Rowland, P. & Stuessy, C. L. (1988, Summer). Matching Mode of CAI to Cognitive Style: An Exploratory Study. Journal of Computers in Mathematics and Science Teaching, 7(4), 36-40.

Rosenberg, H. R., Mintz, S., & Clark, R. E. (1977, August). The Educational Significance of Field Dependence Research. Educational Technology, 17, 43-44.

Shneiderman, B. (1980). Software Psychology. Cambridge, MA: Winthrop Publishers, Inc.

Sims, R. R., Veres, III, J. G., & Shake, L. G. (1989). An Exploratory Examination of the Convergence Between the Learning Styles Questionnaire and the Learning Styles Inventory II. Educational and Psychological Measurement, 49, 227-233.

Spiro, R. J. & Tirre, W. C. (1979). Individual Differences in Schema Utilization During Discourse Processing. Urbana, IL: Center for the Study of Reading. (ERIC Document Reproduction Service No. 165 651).

Stasz, C., Shavelson, R. J., Cox, D. L., & Moore, C. A. (1976). Field Independence and the Structuring of Knowledge in a Social Studies Minicourse. Journal of Educational Psychology, 68(5), 550-558.

Thompson, B. & Melancon, J. G. (1987). Measurement Characteristics of the Group Embedded Figures Test. Educational and Psychological Measurement, 47, 765-772.

Veres, III, J. G. Sims, R. R., & Locklear, T. S. (1991). Improving the Reliability of Kolb's Revised Learning Style Inventory. Educ :tionaland Psychological Measurement, 49, 227-233.

Wachtel, P. L. (1972). Field Dependence and Psychological Differentation: Reexamination. Perpectual and Motor Skills, 35, 179-189.

Whyte, M. M. (1990). Individualistic versus Paired/ Cooperative Computer-Assisted Instruction: Matching Instructional Method with Cognitive Style. Unpublished doctoral dissertation. University of Southern California.

Whyte, M. M., Knirk, F. G., Casey, R. J., & Willard, M.L. (1990-91). Individualistic versus Paired/Cooperative Computer-Assisted Instruction: Matching Instructional Method with Cognitive Style. Journal of Educational Technology Systems, 19(4), 299-312.

Whyte, M. M., Karolick, D. M., Nielsen, M. C., Elder, G. D., & Hawley, W. T. (1995). Cognitive Styles and Feedback in Computer-Assisted Instruction. Journal of Educational Computing Research, 12(2), 195-203.

Wicker, T. E. (1980). The Effects of Cognitive Dissonance or Disequilibrium on Conservation Attainment in Field Dependent and Field Independent Students. Paper presented at the annual meeting of the American Psychological Association, Montreal. (ERIC Document Reproduction Services No. ED 195 323)

Willard, M. L. (1985). An Investigation of the Effects of Cooperative Learning and Cognitive Style in Teaching Word Processing Skills to Adults. Unpublished doctoral dissertation. University of Southern California.

Witkin, H. A. (1979). Socialization, Culture and Ecology in the Development of Group and Sex Differences in Cognitive Style. Human Development, 22, 358-372.

Witkin, H. A. & Goodenough, D. R. (1977). Field Dependence and Interpersonal Behavior. Psychological Bulletin, 84(4), 661-689.

Witkin, H. A. & Goodenough, D. R. (1981). Cognitive Styles: Essence and Origins. Psychological Issues Monograph 51, New York: International Press, Inc.

Witkin, H. A., Lewis, H. B., Hertzman, M., Machover, K., Bretnall Meissner, P., & Wapner, S. (1954). Personality Through Perception. New York: Harper & Brothers Publishers.

Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. (1977). Field-Dependent and Field-Independent Cognitive Styles and their Educational Implications. Review of Educational Research, 47(1), 1-64.

Witkin, H. A., Moore, C. A., Oltman, P. K., Goodenough, D. R., Friedman, F., Owen, D. R. & Raskin, E. (1977). Role of the Field-Dependent and Field-Independent Cognitive Styles in Academic Evolution: A Longitudinal Study. Journal of Educational Psychology, 69(3), 197-211.

Witkin, H. A., Oltman, P. K., Raskin, E., & Karp, S. A., (1971). A Manual for the Embedded Figures Tests. Palo Alto, CA: Psychological Press, Inc.